Arriving at a Natural Solution: Bundling Credits to Access Rangeland Carbon Markets

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Arriving at a natural solution: Bundling credits to access rangeland carbon markets

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On the Ground

- Natural solutions, such as "avoided conversion of grasslands," offer agricultural land managers a way to mitigate climate change while monetizing climate benefits.
- Managers who avoid converting grasslands to other uses, such as row crops, can quantify the amount of stored carbon and sell credits, but high costs of developing carbon credit projects price many landowners out of the carbon market.
- Aggregation can create economies of scale, which lower barriers of entry and allow more landowners to participate in the market.
- Given the current low prices in the carbon market, aggregation is not a panacea and aggregated projects are not financially viable for many landowners.
- As the demand for carbon credits continues to grow, land managers can position themselves to take advantage of carbon market opportunities should prices increase, and projects become financially viable.

Keywords: carbon market, climate change, intermountain west rangelands, natural climate solutions.

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Introduction

Natural climate solutions represent an essential component of a comprehensive strategy to mitigate climate change.[1] Natural climate solutions are land management practices that maintain stored carbon or avoid greenhouse gas emissions.[2,3] Natural climate solutions will be critical to meeting the climate goals outlined in the Paris Climate Agreement. In rangelands, natural climate solutions include practices such as avoided conversion, planting windbreaks, and enhanced grazing methods.[1] Land managers can adopt many of these practices with minimal impact on agriculture and may monetize their climate change mitigation efforts to create new revenue streams for the operation.[4]

We focus on one option in the suite of natural climate solutions, avoided grassland conversion, because it provides the greatest potential to create an additional revenue stream for land managers in rangeland systems and it offers the greatest potential for climate benefits in rangelands.[1,5-7] Avoided grassland conversion in perennial grassland systems mitigates climate change by storing carbon, primarily in soils. Intact perennial grasslands store an estimated 20% of global carbon, and when the grasslands are overgrazed or converted to uses such as annual row crops, up to 50% of the stored carbon is released.[7,8] A study of 21 natural climate solutions for the United States found that avoided conversion of perennial grasslands has the third-most climate mitigation potential behind reforestation and natural forest management of privately owned forests.[1] Avoided conversion of grasslands also provides numerous co-benefits, including conserving biodiversity, air filtration, soil enrichment, water filtration, and flood control.[1,2] To be eligible for an avoided conversion project, landowners need to avoid plowing or otherwise converting perennial grasslands to prevent the release of carbon.[5,6] If landowners meet the minimum project requirements, they can continue to manage the land as a livestock grazing operation and generate additional revenue by selling credits from stored carbon in the voluntary market.

The market for voluntary carbon credits has grown significantly over the past several years, including during the economic downturn caused by the coronavirus disease 2019 pandemic.[9] Demand will likely continue to grow as more corporations and other organizations commit to reducing their carbon footprint to meet various worldwide goals. Ecosystem Marketplace, an organization that tracks the supply and demand of voluntary carbon credits, predicts the supply of carbon credits will need to increase by 15 times in the next decade

to keep up with growing demand.[10] While credits generated through avoided conversion—whether of forests, grasslands, or other ecosystems—already comprise the largest value of credits exchanged on the voluntary market, increasing global demand requires additional projects.[9]

To meet the growing demand for credits while also benefiting producers on rangelands there is a need to improve market access and lower barriers to developing avoided grassland conversion projects.[3] Although the sale of carbon credits offers producers a means of generating additional revenue alongside a livestock operation, there are difficulties associated with the carbon market. The current price for carbon credits on the voluntary market is low on a per-hectare basis, particularly when compared with other opportunities and considering financial risks due to the upfront costs associated with accessing the market. For example, the US Department of Agriculture's Conservation Reserve Program often results in a greater per-hectare payment, is much less onerous on landowners, and entails substantially less financial risk.[11,12] The low price of credits and high upfront costs make carbon credit projects financially infeasible for many landowners.

Here, we show how aggregation of avoided conversion carbon credits or projects can create economies of scale and allow more landowners to access the market. We base our evaluation of the aggregation approach on an analysis of voluntary carbon registry protocols and methodologies, interviews with experts involved in the carbon credit industry, and an estimate of expenses derived from consultations with staff essential to a carbon credit project. We consulted experts, including land trust staff, carbon project developers (several with experience aggregating carbon projects), and verification and validation bodies. We demonstrate the hypothetical financial benefits of aggregating carbon projects, but readers should not treat this as a roadmap to implementing an aggregated project. The carbon market is variable, and each property will have unique features that make aggregation more or less viable. The intended audience for our article is land stewards, land trusts, or others interested in the economic opportunity offered by the voluntary carbon market. Though avoided grassland conversion is a natural climate solution that applies in contexts around the world, our data come from the western Great Plains and Rocky Mountain West regions of the United States; thus, those regions are the focus of our discussion.

We provide a brief description of a potential option to open the voluntary carbon market to more landowners. For more information regarding the carbon market, the registries, or the project development process, land managers should speak to a registry, project developer, or land trust with experience with carbon projects.

Background

The carbon market is comprised of two sectors, regulatory and voluntary.[13] The regulatory market exists for entities that, by government mandate, are compelled to offset their greenhouse gas emissions. The voluntary carbon market serves entities interested in willingly offsetting their greenhouse gas emissions by buying carbon credits or offsets. There are subsets of the voluntary market based on the types of projects that generate credits, such as forestry, methane capture, and avoided conversion projects.[9]

In an avoided conversion project, once a landowner meets certain eligibility requirements set by registries, then certifies they will maintain their land as range for some time, they may be issued credits.[5,6] Lands eligible to generate carbon credits include lands dominated by perennial native or introduced grasses, lands containing some forbs and shrubs, and generally any land with <10% tree canopy cover. To be eligible, the land must have been managed as range or pasture for at least 10 years before enrollment. Each registry has further nuances to eligibility requirements. The registries require long-term protection and restriction of the land on which credits are generated. Landowners are required to protect their land with a conservation easement (perpetual or term) or other similar legal instrument to limit the use of the land to primarily grazing agriculture. The instrument limiting the use of the land must be held and monitored regularly by a qualified land trust or other easement holder, similar to any other conservation easement transaction. Registry methodologies and protocols outline the level and timing of the restrictions required in the conservation easement. Landowners can opt to limit the use of only the areas of their property generating carbon credits, known here as eligible areas, or they can limit the use of the entire property.

In the United States, two primary registries work on avoided conversion projects, the American Carbon Registry (ACR) and the Climate Action Reserve (CAR).[5,6] There are other registries that work in the United States, but only ACR and CAR have completed avoided conversion projects relevant to a discussion of aggregation. Registries are standard-making bodies setting requirements that projects must meet before the projects can generate and sell credits. The registries set methodologies or protocols to outline project requirements. The registries also create a means of quantifying the number of credits a project will generate and outline the long-term obligations of landowners. Registries track credit issuance and ensure the legitimacy of all carbon credits. Overall, registries provide a means of ensuring that before credits are sold there is adequate protection of the stored carbon for which the buyer is paying and ensure that after credits are sold the credits cannot be resold or "double-counted."

The ACR methodology for avoided conversion is called the Avoided Conversion of Grasslands and Shrublands Methodology (ACoGS).[6] The ACoGS methodology may require more upfront due diligence from the project developer, such as biogeochemical modeling, to determine eligible areas and carbon storage more precisely. However, because of the increased project due diligence, projects developed under the ACR methodology may generate more credits. ACR requires a minimum 40-year commitment from landowners to protect and maintain their land as rangeland. CAR calls its avoided conversion practice the Grasslands Protocol.[5] CAR

has developed tools that streamline early project development stages, but the CAR protocol may lead to fewer credits generated. CAR requires a 100-year minimum commitment from landowners to protect rangelands from conversion.

Both ACR's methodology and CAR's protocol allow for grazing in conjunction with the carbon project, with some qualifications and limitations.[5,6] Under ACR, grazing is specifically allowed, but any grazing must comply with the conservation easement or other legal instrument. Under CAR, grazing is permitted but must be reported annually, and rangeland health must be monitored in accordance with the Bureau of Land Management's guide on *Interpreting Indicators of Rangeland Health*.[14] The limitations on grazing are minimal, but managers should be cognizant of the potential impact on their operation.

For landowners, getting a project from initial recruitment to sale can be time-consuming and expensive. Therefore, landowners with land that generates fewer credits generally cannot compete in the market. The registries, however, allow for aggregation so that the upfront costs of developing a carbon credit project are spread across multiple projects or landowners.[5,6] Aggregation creates economies of scale so that a single landowner or project does not bear all the fixed project costs. The aggregation process varies slightly between the registries, but each functionally achieves the same result. For brevity, a combination of projects or landowners is referred to as an aggregate or aggregated project. Below we describe the aggregation process and some of the benefits and drawbacks of aggregating carbon credit projects (Fig. 1).

Aggregation

Aggregation is the process of bundling carbon credits across multiple projects or landowners to create economies of scale and open the market to more landowners. The registries leave flexibility in the structure of aggregated projects so that parties may adjust their rights and responsibilities based on the project's goals.[5,6]

Parties and roles

In an aggregated project, there is a minimum of five required roles: landowner, easement holder, project developer, verification/validation body, and aggregator[5,6] (Fig. 2). Some of these roles can be fulfilled by the same party.

Landowner. The landowner owns the land on which the credits will be generated. Depending on the structure selected by the parties, the landowner may keep ownership of the carbon credits or transfer ownership to one of the other parties.[5,6] The decision regarding who owns the carbon credits depends on the allocation of risk. Whoever owns the credits will hold most of the project's risk. In a typical transaction, the project developer will own the credits. Landowners may work directly with the registries as their own project developer; however, landowners may want to avoid that risk. Landowners can limit their involvement in the project to as little as simply confirming annual ranch activities, expanding their role to be that of a project developer, or maintaining a degree of involvement between the two extremes.

Easement holder. The easement holder closes and holds the conservation easement (or similar legal instrument) required by the registries.[5,6] If the easement holder is a land trust, it may take on a more significant role in the project by functioning as a project developer or an aggregator. Registries require the easement holder to review the agricultural operation's activities annually and ensure the landowner has not released any stored carbon through an incompatible land use. Conservation easements typically restrict incompatible land uses, so the easement holder's monitoring of the easement will confirm the presence of an incompatible use. The project developer confirms any on-ranch activities identified by the land trust. Most of the easement holder's obligations will be similar to a typical conservation easement project. However, carbon credit projects require a more in-depth annual review of the project by easement holders, resulting in added operational expenses, primarily in the form of staff time.

Project developer. Landowners, land trusts, or other third parties may fill the role of project developer.[5,6] The role of the project developer is to confirm the credit generation potential of the project, monitor the eligible areas and on-ranch activities, maintain necessary paperwork and records, and act as a liaison with the registries. Project developers assume a substantial portion of the risk of the project because they typically own any generated carbon credits. As the owner of the credits, the project developer will ensure compliance with the methodology or protocol and manage payouts to landowners after the sale of credits. Further, project developers are responsible for reporting any release of stored carbon to the registries. In the event of a reversal or loss of stored carbon, project developers must have a mitigation plan that may include purchasing replacement credits for the amount of carbon lost. The mitigation burden may pass to the landowner or remain with the project developer depending on the agreement. As the owner of the credits, the project developer is responsible for removing credits from the buffer pool or implementing other mitigation practices to cover any reversals. Aggregated projects must share a common project developer.

Verification/validation body. The verification/validation body (VVB) fills the role of verifying and validating projects and cannot play another role in the aggregation. All aggregated projects require verification and validation by a certified third party.[5,6] The VVB must be certified by the registries and must be a neutral third party. The third-party VVB initially validates the project after the conservation easement has closed. Validation is a way to confirm the project meets all of the requirements of the methodology or protocol. After the project has been validated and the crediting period has begun, the VVB will verify the project either once per "verification cycle" or before new credits are issued. A verification cycle is the maximum amount of time allowed between third-party verifications of the project (Table 1). A project may be verified as often as once per year but may not be verified less than once per verification cycle. The project developer is responsible for

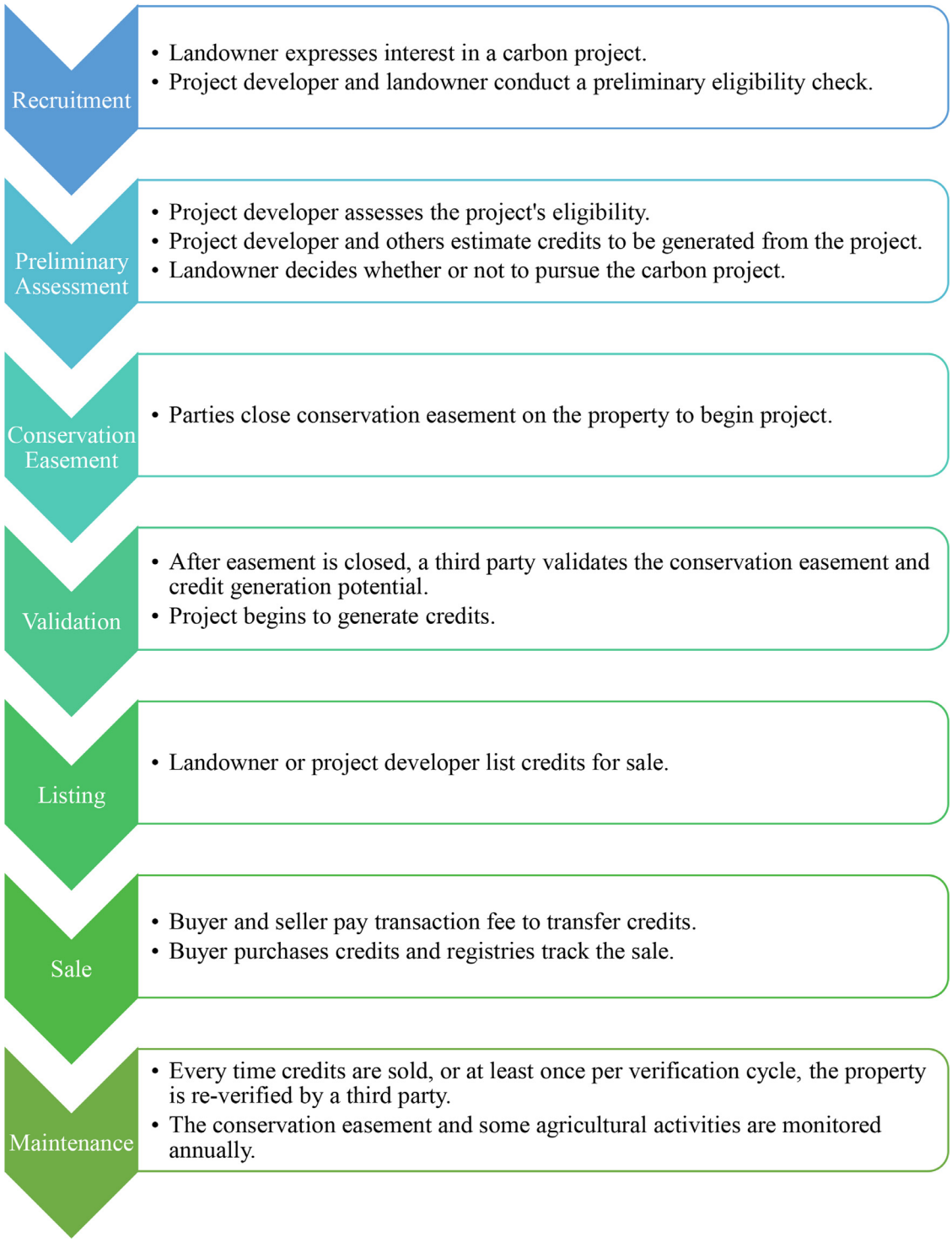

Figure 1. The general process an avoided conversion carbon credit project follows as it moves from recruitment to project maintenance. To move from Recruitment to closing the Conservation Easement may take >2 years. Then Validation must happen shortly after the Conservation Easement is closed. If landowners pass validation and verification processes, they may list credits for sale.

selecting the VVB and must periodically select a new VVB to increase transparency and ensure accountability.

Aggregator. To form an aggregate project, there must be a common project developer.[5,6] The aggregator takes on some of the responsibilities of the project developer by functioning as the liaison to the registries. In many cases, the project developer is also the aggregator. The largest role of the aggregator is to develop multiple projects in tandem, to create the economies of scale needed for efficiency. Any of the above parties, except the VVB, may act as the aggregator.

Table 1
Select critical processes timetable comparison for two primary registries working on avoided conversion projects: the American Carbon Registry (ACR) and the Climate Action Reserve (CAR).[5,6]

Process	ACR	CAR
Permanence period	40 years	100 years
Verification cycle	5 years	6 years
Pre-enrollment maintenance of grassland	10 years	10 years

Note: Registries set requirements for projects to meet before the projects can generate and sell credits. The permanence period is a timeline of 40 to 100 years for the avoided conversion project. The verification cycle is the maximum amount of time allowed between third-party verifications of the project. For the pre-enrollment maintenance of grassland, the land must have been managed as range or pasture for at least 10 years before enrollment.
ACR indicates American Carbon Registry; CAR, Climate Action Reserve.

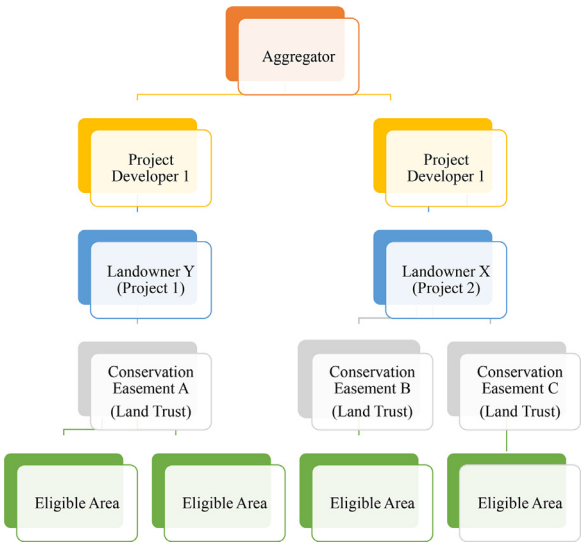

Figure 2. Example of the parties and hierarchy of an aggregated project. An aggregated project must share a common project developer. Each landowner may have a single conservation easement covering multiple eligible areas and other noneligible lands, or multiple conservation easements only covering eligible areas. The land trust may, in some cases, function as the project developer or aggregator.

Process

Aggregated projects generally follow seven sequential steps (Fig. 1). The project starts with the initial confirmation of eligibility and estimation of the credit generation potential.[5,6] Then, the landowner closes a conservation easement on, at a minimum, the eligible areas. After the easement encumbers the land, the VVB validates the project. If the project passes validation, the registry will release credits, which the parties can sell. The landowner will be obligated to maintain the land as rangeland for the timeframe required by the registry, and the VVB will periodically verify the project to ensure the landowner is meeting their obligations.

Eligible areas are the smallest parcel of land on which carbon credits can be generated. A single landowner may have one or several eligible areas (Fig. 2).[5,6] A landowner may opt to close a conservation easement on only the eligible areas, or they may encumber the entire property. At a minimum, any land that generates credits must be covered by a conservation easement. Based on their operational needs and in consultation with the easement holder and project developer, the landowner has the flexibility to decide the number and size of easements for the property. This assumes the easement holder is willing and able to hold multiple easements on the same property. The parties will have to determine the appropriate balance for the number of eligible areas, easements, and landowners within the aggregate.

Eligible conservation easements must restrict the conversion of the property by disallowing plowing, tilling, and other incompatible uses.[5,6] After the conservation easement is closed, a third-party VVB will initially validate the project. The validation process will ensure the conservation easement and the rest of the project meet the registry requirements and confirm the number of credits the project can generate. In an aggregate, the common project developer may work with one verification body and may receive a bulk discount for the validation of all projects.

After the initial validation, a VVB will need to verify the project periodically.[5,6] Verification may occur as often as annually but must be at least once per verification cycle (Table 1). If the project passes the verification process, the project will be issued credits. After a project is issued credits, the project developer or aggregator may sell those credits. Again, aggregation streamlines and economizes the verification process, as the same verification body can work to verify all projects.

Certain on-ranch activities must be reported to the registry every year for the project's life.[5,6] Typically, the easement holder will conduct this annual monitoring in conjunction with their conservation easement monitoring obligations. The obligation to track operational inputs is another consideration for landowners, as they will have to more closely track certain ranch activities to provide a summary to the easement holder. Ranch activities requiring tracking include fuel and electricity usage, among other activities.

If stored carbon is released from the project area at any point in the life of the project, a reversal has oc-

curred.[5,6] Reversals can be unavoidable/unintentional, or avoidable/intentional. VVBs identify reversals in the verification process. Certain natural occurrences like floods that cause erosion will qualify as unintentional reversals. It is unclear whether the registries will consider the encroachment of trees and shrubs or the impacts of climate change on soil carbon budgets as avoidable or unavoidable.

To mitigate the loss of stored carbon from reversals, the registries require the project developer to set aside a percentage of the total credits from a project into a buffer pool.[5,6] In the event of an unintentional reversal, the loss will be covered by removing credits from the buffer pool. If the landowner has not acted negligently or mismanaged the land, the removal of credits from the buffer pool may be limited. Removing credits from the buffer pool will not ultimately affect the landowner's bottom line because they were not allowed to profit from those credits anyway. In the case of an unavoidable reversal, the landowner may still sell credits. Avoidable or intentional reversals may result in the landowner losing the right to sell credits for at least the verification cycle in which the reversal occurred, and the project developer may have to purchase credits from another project to account for the lost carbon.

If the parties properly follow all the steps above, the registry will issue the project credits, minus those placed in the buffer pool.[5,6] Once a project is issued credits, the parties may sell those credits either on the open market or through preexisting agreements with buyers. Once the buyer has used a credit to offset their greenhouse gas emissions, the credit is retired so that it may not be sold again. If credits are issued in an aggregate, the project developer may have a better opportunity to market and sell a large block of credits to buyers looking to purchase many credits at once, which would prevent credits from sitting unsold on the market.

The project development process can be time-consuming and expensive for the parties involved. To open the market to more landowners, economies of scale must be created so that one project does not have to bear all the development costs.

Benefits of aggregation

There are significant costs in getting a carbon credit project from the recruitment phase to selling credits. Many of these expenses are fixed (i.e., not on a per-landowner or per-hectare basis), so they can be spread across multiple projects through aggregation. Aggregation creates three primary benefits for landowners developing carbon credit projects:

- streamlined communication with the registry;
- dispersed fixed costs proportionately across all landowners or projects in the aggregate and;
- ability to negotiate for and sell larger blocks of credits to large buyers.

As an example of the benefits of aggregating carbon credits, we compared the expenses of a hypothetical landowner with 200 eligible hectares (500 acres), developing their project alone, to a hypothetical landowner with 200 eligible hectares in an aggregate of 10 landowners, each with 200 eligible hectares (Table 2). One hectare (2.47 acres) can generate from 1¼ credits to 3 credits, depending on several factors. As a result of the additional due diligence work required by the ACR ACoGS methodology, projects developed under ACR tend to generate more credits than projects under CAR. We account for this in our estimates by increasing the number of credits generated on the same project by 10%. Though it is hypothetical, our example is a reasonable illustration of the real-world implications of aggregation (Table 2; Appendix A). Given a lack of available data from completed projects, we used hypothetical data based on communications with project developers, registry information, and publicly available information and had seven experts with direct experience with carbon projects review our estimates and confirm they are reasonable estimations. However, each project is unique, and each project or aggregate will have unforeseen nuances altering the expenses. We included the minimum expenses required by an average project and we did not intend this example to be an exhaustive look at all potential and unforeseeable expenses that may arise (Table 2).

The costs of completing a carbon credit project can be broken down into three main categories: first-year expenses, annual expenses, and expenses of a credit issuance (Table 2). The largest expenses in developing a project are the initial validation and subsequent verification, which are both fixed costs. By aggregating projects or landowners, aggregators can economize the most significant expenses. Some of the expenses may be paid directly by the landowner, others may be those incurred by the easement holder or project developer, which will be paid out of the project revenue (Table 2). Many of the expenses in developing an aggregate are on a per-project or per-landowner basis, so a landowner's bottom line on these expenses is not affected by aggregation. However, several of the largest expenses in developing an aggregate are fixed, and individual landowners in an aggregate will realize cost savings compared with landowners developing projects alone. Below is a summary and explanation of the expenses (see Table 2 and Appendix A for more details).

First year expenses[i]. First year expenses are those incurred by a landowner, easement holder, and project developer in preparing the project to sell credits. First, there are the costs of registration. These include the costs of opening an account with the registries and staff time associated with opening the account. Project developers or aggregators need only open one account, making most of the registration expenses fixed. Second, is the preliminary assessment, where the project developer or easement holder analyzes the land's ability to generate credits to determine if the project is worth pursuing. The preliminary assessment also includes the costs of recording the conservation easement (or another instrument). Note that the costs of closing a conservation easement can be significant and vary widely by easement holder and project.[15-17] The costs of an easement are on a per-project basis and are not impacted by aggregation. Landowners and project developers should be aware this is an additional expense associated with

[i] Information on first-year expenses came from interviews with project developers, verification/validation bodies, the registries, and land trusts.

Table 2
Estimated minimum required expenses of a hypothetical scenario for an individual landowner in an aggregation of 10 landowners compared with an individual landowner developing a project alone.[5,6]

First year expenses	*Individual landowner in an aggregate*		*Individual landowner*	
	ACR	CAR	ACR	CAR
Registration	$1,300	$790	$4,000	$4,000
Preliminary assessment	$2,600	$1,100	$2,600	$1,100
Validation	**$1,625**	**$1,625**	**$16,250**	**$16,250**
Total first year expenses	***$5,525***	***$3,515***	***$22,850***	***$21,350***
Annual expenses				
Registration	**$550**	**$520**	**$1,000**	**$1,000**
Accounting	**$250**	**$250**	**$2,500**	**$2,500**
Reporting	$500	$500	$500	$500
Total annual expenses	***$1,300***	***$1,270***	***$4,000***	***$4,000***
Credit issuance expenses				
Verification	**$1,050**	**$1,050**	**$10,500**	**$10,500**
Marketing/Sale	$343	$345	$343	$345
Total credit issuance expenses	***$1,393***	***$1,395***	***$10,843***	***$10,845***

Note: See Appendix A for a detailed description of the numbers and assumptions used. Bold text indicates the expense categories with the largest potential cost savings.
The numbers used is this analysis are approximate and hypothetical. This is not intended to be a roadmap for how to aggregate carbon credit projects. Instead, this demonstrates how aggregation can create value for landowners interested in the carbon market. There are likely many more unforeseen costs that arise through the development of a project. This table intends to show the minimum required expenses that could benefit from aggregation.
ACR indicates American Carbon Registry; CAR, Climate Action Reserve.

developing a carbon project, but the closing of a conservation easement may also qualify landowners for other financial incentives, which are beyond the scope of our article. Mostly, the preliminary assessment expenses are on a per-landowner basis. The final first-year expense is validation. Validation is one of the most significant expenses in developing a carbon project and includes project developer staff time to find, hire, and work with the VVB. The costs of validation are fixed.

Annual expenses[ii]. These annual expenses are required each year for the project's life. Annual expenses include the costs of maintaining a registry account, accounting for the flow of cash and credits, and tracking the project to report to the registries. Several of the annual costs are on a per-landowner basis, and several are fixed.

Credit issuance expenses[iii]. These expenses are incurred when credits are issued to the project developer and sold. These expenses include verification and marketing or sale expenses. Verification must occur at least once per verification cycle, regardless of credit sale. Verification, which follows a similar process to validation in the first year, is a fixed cost. Marketing expenses are on a per-landowner basis. Annual expenses are still incurred in years where credits are sold.

The expenses with the greatest per-landowner cost reduction due to aggregation include validation, registration, accounting, and verification (Table 2). An individual landowner with approximately 500 credits developing a project in an aggregate will realize significant cost savings compared with a similarly situated landowner developing a project alone. The economies of scale realized through an aggregation can make some avoided conversion projects financially viable where they would have been cost-prohibitive individually.

Another benefit of aggregation that is much more difficult to quantify is the benefit of marketing or selling aggregated credits. Buyers of carbon credits may be looking for "charismatic carbon" or carbon credits developed in a way that buyers can identify as creating co-benefits.[18] Buyers of credits like telling the story of where and how their purchased credits were generated. Aggregation can help buyers tell a story of the credits they are buying by creating a narrative around conserving rangelands, helping agricultural communities, and supporting the food system. There is also value for project developers to sell large blocks of these charismatic credits rather than a piecemeal approach that results from multiple individual projects each attempting to sell credits.

Though the ability to aggregate does allow landowners to recognize significant savings over the life of the project, the price of carbon credits, compared with the expenses to develop a project, is currently too low for many landowners to justify a carbon credit project without finding other revenue sources to "stack" with the carbon project. We see carbon credits fitting into a larger conservation funding scheme, including a conservation easement, a payment for ecosystem services initiative––other than carbon—or other components of the portfolio of conservation strategies.[19] Even with aggregation, until the

[ii] Information on annual expenses came from interviews with project developers, the registries, and land trusts.
[iii] Information on credit issuance expenses came from interviews with project developers, verification/validation bodies, and land trusts.

price of carbon credits increases, carbon credit projects will largely remain a supplemental funding source, while other funding sources can create the greatest return for landowners. Once the price of carbon credits reaches a threshold, additional training and technical capacity in the land trust community and among other conservation practitioners working in rangeland systems will be needed to scale up adoption and increase the role of rangeland conservation in meeting climate change goals.[2-4,19]

Working through landowner or rancher-led conservation organizations can help facilitate trust and broad landowner adoption.[20] Landowner and rancher-led or focused groups have demonstrated that community-based conservation is possible in a rangeland context. Agricultural landowners can take comfort if they decide to pursue a carbon credit project that agricultural-focused conservation groups exist around the country and can support projects while enabling ongoing agricultural activities.

Conclusions

Landowners and managers should be aware of opportunities to diversify their operation's revenue through avoided conversion of grasslands projects in the voluntary carbon credit market. Avoided conversion projects can offer an alternative revenue stream to help support livestock operations and agriculture-based livelihoods. The registries making the rules for entering the carbon credit market allow for and encourage aggregation of credits to create economies of scale. By bundling credits with other landowners, producers who would otherwise be priced out of the market can create economies of scale to enter the market without unduly sacrificing their share of the profits.

Despite the promise of aggregation, the practice does have some downfalls. First and foremost, an aggregation of projects may reach the point where too many projects are bundled, and the overall management becomes unwieldy. The management of an aggregation requires considerable time and expertise from several entities. If there are too many projects, it becomes more likely that issues will become overlooked, and cost savings will not be realized. Second, all carbon credit projects require a permanent or long-term restriction on land use. Such long-term restrictions on land may not be viable for every landowner or agricultural operation. Third, the prices of voluntary carbon credits are still low given the effort required and the costs of developing a project. Aggregation is currently an option but becomes much more feasible after an increase in the price of carbon credits.

Additionally, there are limitations in the broader voluntary carbon credit industry. First, there is evidence voluntary carbon credits do not result in a net benefit for climate mitigation efforts.[21,22] There are issues related to leakage and additionality, which mean credits sold in the voluntary market may not result in a net removal of carbon from the atmosphere.[23] Second, voluntary carbon credits may be used by buyers to justify the continuation of polluting activities.[24] This "license to pollute" that credits create may mean they are a detriment to overall efforts to address climate change.[25] Third, the registries require a timeline of 40 to 100 years of permanence, which in the timeline of climate mitigation may not be long enough for truly permanent carbon storage.[26,27] Finally, there is uncertainty about how the registries and verification bodies would handle the impacts of climate change on a project.[5,6] For example, shrub encroachment due to climate change may impact the carbon storage ability of a project, but there is uncertainty if the registries would consider that change a reversal.

Although aggregation and the voluntary carbon market have disadvantages, avoided conversion projects still offer an opportunity worth considering for rangeland owners. The payment for a voluntary carbon credit project can offer a "cherry on top" for landowners interested in conserving their land but who might not receive enough money from the sale of a conservation easement.[28] Additionally, the protections for a carbon project, regardless of their impact on carbon emissions, still result in co-benefits to rangeland ecosystems by restricting conversion.[7] Finally, the payments landowners receive from voluntary carbon credits can help maintain the financial viability of an agricultural operation.[28]

Bundling carbon credits presents a clear opportunity for landowners, yet it is not economically viable for many landowners without additional revenue from stacked projects. Currently, the price of carbon credits on the voluntary market is too low for landowners to justify the expense of pursuing a project. There is, however, a great deal of remaining uncertainty. There is uncertainty regarding the impacts of climate change on carbon credits, the effect of increased demand, and the effect of increased supply on price points. As demand for carbon credits continues to increase and the effects of climate change further impact the world food system,[29] the price of carbon credits is likely to rise.[16] To meet the estimated 15-fold increase in credit demand will require a significant increase in the number of landowners in various landscapes working to supply credits.[10] At that point, prices will have to rise to more appropriately incentivize landowners to enter the market.[3] By understanding the benefits of aggregation, landowners and managers can ensure they are in a position to enter the market when the time is right.

Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.rala.2022.04.001.

References

1. Fargione JE, Bassett S, Boucher T, et al. Natural climate solutions for the United States. *Sci Adv*. 2018; 4(11):1–15. doi:10.1126/sciadv.aat1869.
2. Gosnell H, Charnley S, Stanley P. Climate change mitigation as a co-benefit of regenerative ranching: insights from Australia and the United States. *Interface Focus*. 2020; 10(5). doi:10.1098/RSFS.2020.0027.
3. Ritten JP, Bastian CT, Rashford BS. Profitability of carbon sequestration in western rangelands of the United States. *Rangel Ecol Manag*. 2012; 65(4):340–350. doi:10.2111/REM-D-10-00191.1.
4. Gosnell H, Robinson-Maness N, Charnley S. Profiting from the sale of carbon offsets: a case study of the Trigg Ranch. *Rangelands*. 2011; 33(5):25–29. doi:10.2111/1551-501X-33.5.25.
5. DuBusson M, Zavariz B; 2020 Accessed April 3, 2022. https://www.climateactionreserve.org/wp-content/uploads/2020/02/Grassland_Protocol_V2.1.pdf.
6. American Carbon Registry. Methodology for the quantification, monitoring, reporting and verification of greenhouse gas emissions reductions and removals from: Avoided Conversion of Grasslands and Shrublands to Crop Production. 2.0.; 2019. Accessed April 3, 2022. https://americancarbonregistry.org/carbon-accounting/standards-methodologies/methodology-for-avoided-conversion-of-grasslands-and-shrublands-to-crop-production/acr-acog-2-0_2019-10.pdf
7. Sanderson JS, Beutler C, Brown JR, et al. Cattle, conservation, and carbon in the western great plains. *J Soil Water Conserv*. 2020; 75(1):5A–12A. doi:10.2489/JSWC.75.1.5A.
8. Dean C, Kirkpatrick JB, Harper RJ, Eldridge DJ. Optimising carbon sequestration in arid and semiarid rangelands. *Ecol Eng*. 2015; 74:148–163. doi:10.1016/J.ECOLENG.2014.09.125.
9. Donofrio S, Maguire P, Zwick S, Merry W. *State of the Voluntary Carbon Markets*. Voluntary carbon and the post-pandemic recovery markets; 2020 Accessed April 4, 2022 *https://www.forest-trends.org/publications/state-of-the-voluntary-carbon-markets-2020-2/* .
10. Donofrio S, Maguire P, Zwick S, Merry W. *State of the Voluntary Carbon Markets*. The only constant is change. Ecosys Marketplace; 2020 *https://share.hsforms.com/1FhYs1TapTE-qBxAxgy-jgg1yp8f* Accessed April 4, 2022.
11. Farm Service Agency (FSA). Conservation reserve program annual summary and enrollment statistics FY 2020. Accessed January 31, 2022. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Conservation/PDF/Annual%20Summary%202020.pdf.
12. Farm Service Agency (FSA). Conservation reserve program fact sheet. 2020. Accessed January 14, 2022. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/crp-general-signup-56-enrollmentperiod-june-2021.pdf
13. Ecosystem Marketplace. Carbon Market: Overview. Accessed June 2, 2021. https://www.ecosystemmarketplace.com/marketwatch/carbon/
14. Pellant M, Shaver P, Pyke D, Herrick D. *Interpreting indicators of rangeland health: Technical Reference 1734-6 USDI Bureau of Land Management*. National Science and Technology Center; 2005 Accessed July 19, 2021 *https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1043944.pdf* .
15. Wyoming Stock Growers Land Trust. Landowner information packet. Accessed January 4, 2022. https://wsglt.org/wp-content/uploads/2021/10/WSGLT-Landowner-Information-Packet_05.2021.pdf
16. Colorado Cattlemen's Agricultural Land Trust. The costs and benefits of conservation easements. Accessed January 4, 2022. https://ccalt.org/wp-content/uploads/2020/01/Costs-Benefits-of-Conservation-2020_Clean.pdf
17. Texas Agricultural Land Trust. Cost. Accessed January 18, 2022. https://www.txaglandtrust.org/resources-2/cost/.
18. Gifford L. You can't value what you can't measure": a critical look at forest carbon accounting. *Clim Chang*. 2020; 161(2):291–306. doi:10.1007/S10584-020-02653-1.
19. Bennett DE, Pejchar L, Romero B, Knight R, Berger J. Using practitioner knowledge to expand the toolbox for private lands conservation. *Biol Conserv*. 2018; 227:152–159. doi:10.1016/J.BIOCON.2018.09.003.
20. Bennett DE, Knapp CN, Knight RL, Glenn E. The evolution of the rangeland trusts network as a catalyst for community-based conservation in the American West. *Conserv Sci Pract*. 2021; 3(1):e257. doi:10.1111/CSP2.257.
21. Mendelsohn R, Litan R, Fleming J. A framework to ensure that voluntary carbon markets will truly help combat climate change. Accessed January 20, 2022. https://www.brookings.edu/research/a-framework-to-ensure-that-voluntary-carbon-markets-will-truly-help-combat-climate-change/
22. Nasralla S, Twidale S. Carbon offset credits and their pros and cons. *Reuters*. 2022. Accessed January 20, 2022. https://www.reuters.com/article/us-climate-change-carbon-offsets/factbox-carbon-offset-credits-and-their-pros-and-cons-idUSKBN2AP1FZ .
23. West TAP, Börner J, Sills EO, Kontoleon A. Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon. *Proc Natl Acad Sci U S A*. 2020; 117(39):24188–24194. doi:10.1073/PNAS.2004334117/-/DCSUPPLEMENTAL.
24. Merger E, Pistorius T. Effectiveness and legitimacy of forest carbon standards in the OTC voluntary carbon market. *Carbon Balance Manag*. 2011; 6(1):1–12. doi:10.1186/1750-0680-6-4/TABLES/1.
25. Carlson K. Ridding PES systems of the "pay to pollute" principle: PES optimization strategies. *Sustainable Development Law & Policy*. 2015; 16(1) Accessed April 4, 2022. http://digitalcommons.wcl.american.edu/sdlp http://digitalcommons.wcl.american.edu/sdlp/vol16/iss1/6

26. Ruseva T, Hedrick J, Marland G, Tovar H, Sabou C, Besombes E. Rethinking standards of permanence for terrestrial and coastal carbon: implications for governance and sustainability. *Curr Opin Environ Sustain*. 2020; 45:69–77. doi:10.1016/J.COSUST.2020.09.009.
27. Miltenberger O, Jospe C, Pittman J. The good is never perfect: why the current flaws of voluntary carbon markets are services, not barriers to successful climate change action. *Front Clim*. 2021; 0:130. doi:10.3389/FCLIM.2021.686516.
28. Malotky B. Free-range carbon. *West Conflu*. 2022. Accessed January 20, 2022. https://westernconfluence.org/free-range-carbon-2/ .
29. Briske DD, Ritten JP, Campbell AR, Klemm T, King AEH. Future climate variability will challenge rangeland beef cattle production in the Great Plains. *Rangelands*. 2021; 43(1):29–36. doi:10.1016/j.rala.2020.11.001.

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